E-PROCEEDINGS

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"Fostering a Culture of Innovation and Entrepreneurial Excellence"

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PTDI, UiTM Cawangan Johor
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A-ST069: ADVANCED SOLAR STREET LIGHTING SYSTEM WITH FAULT DETECTION

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ABSTRACT

This innovative Advanced Solar Street Lighting System with Fault Detection optimizes energy use and enhances maintenance through advanced features. It integrates light-dependent resistor (LDR) sensors for automatic LED streetlight activation based on ambient light and passive infrared (PIR) sensors to adjust light intensity dynamically by detecting vehicles and pedestrians. Powered by a solar photovoltaic (PV) system, it operates independently of the grid, ensuring sustainability. Wi-Fi-enabled remote monitoring simplifies maintenance by enabling real- time fault detection, such as identifying damaged bulbs. The system offers significant advantages, including energy savings of up to 63.5% through LED technology, adaptive intensity control, and solar power. Its unique combination of automation, energy efficiency, and remote monitoring reduces carbon footprints, operational costs, and electricity bills. With strong commercialization potential, this system can be deployed as a stand-alone solution or integrated into smart city projects, improving urban safety, reducing greenhouse gas emissions, and lowering costs. It supports resilient infrastructure development while contributing to socio-economic benefits and environmental sustainability.

Keywords: Intelligent Street Lighting System, Solar Power, Remote Monitoring, Internet of Things (IoT), Energy Efficiency.

1. Product Description

The Advanced Solar Street Lighting System with Fault Detection is an energy-efficient solution that integrates renewable energy, advanced sensors, and IoT technology to optimize urban infrastructure. The system features key components such as a solar panel, ESP32 microcontroller, LDR sensors, PIR sensors, and LED indicators, as shown in **Figure 1**. These elements work together to enhance lighting performance while reducing energy consumption. The system begins with ambient light detection via Light-Dependent Resistors (LDR), which controls the automatic switching of LED streetlights. Passive Infrared (PIR) sensors enhance functionality by detecting motion, enabling dynamic adjustments in light intensity for increased visibility and energy efficiency. A secondary LDR monitors the brightness of the streetlights to identify faults, triggering green or red LEDs to indicate normal operation or issues, respectively. The ESP32 microcontroller processes sensor data and executes control algorithms, as outlined in **Figure 2**. Wi-Fi integration enables real-time data transmission to a remote server for monitoring via a mobile app. The schematic diagram is further detailed in **Figure 3**. This combination of hardware and software offers

a scalable, sustainable solution for energy- efficient street lighting, ideal for both urban and rural applications.

2. Block Diagram, Flow Charts and Schematic diagrams

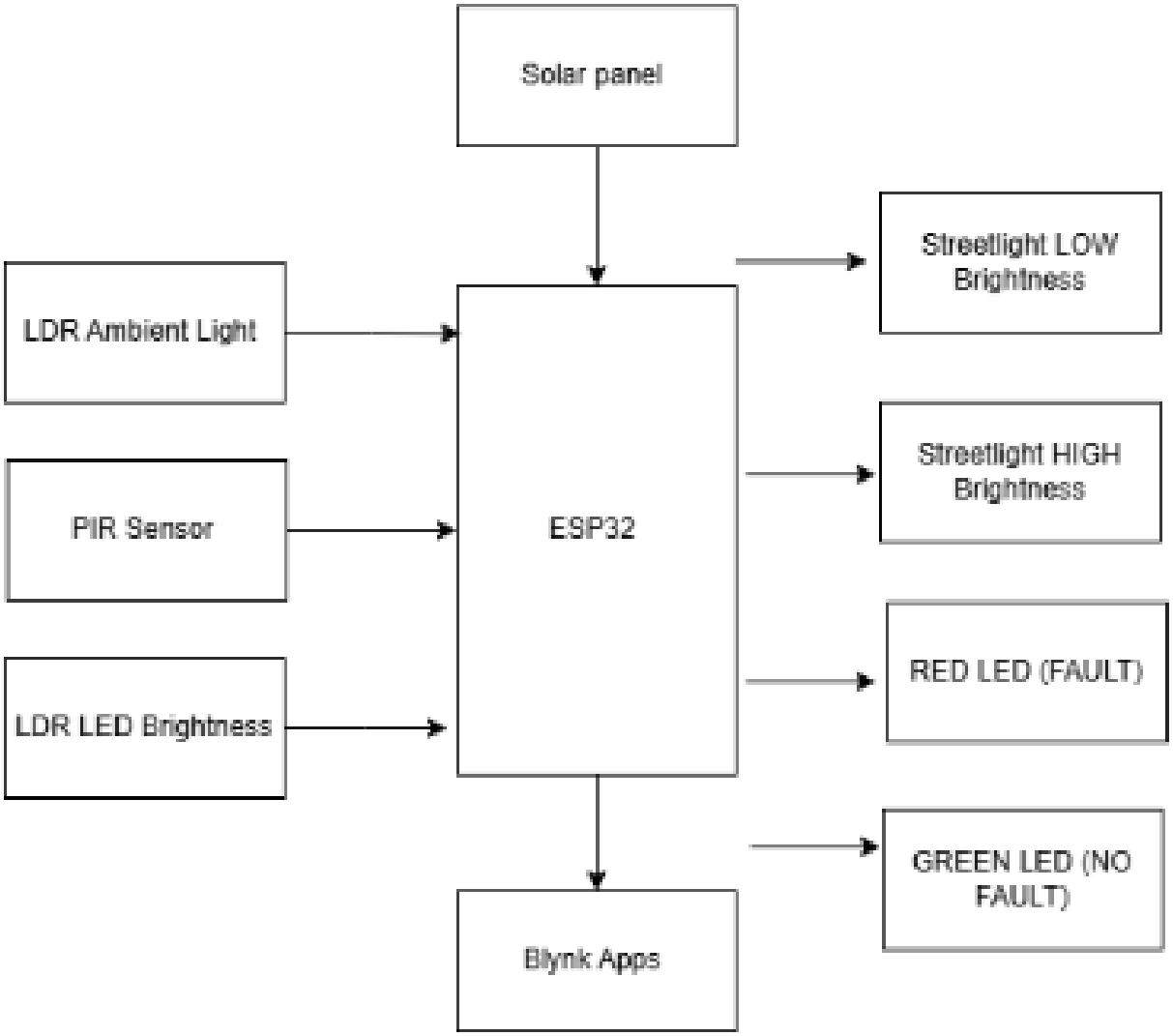

Figure 1. Block Diagram of the system.

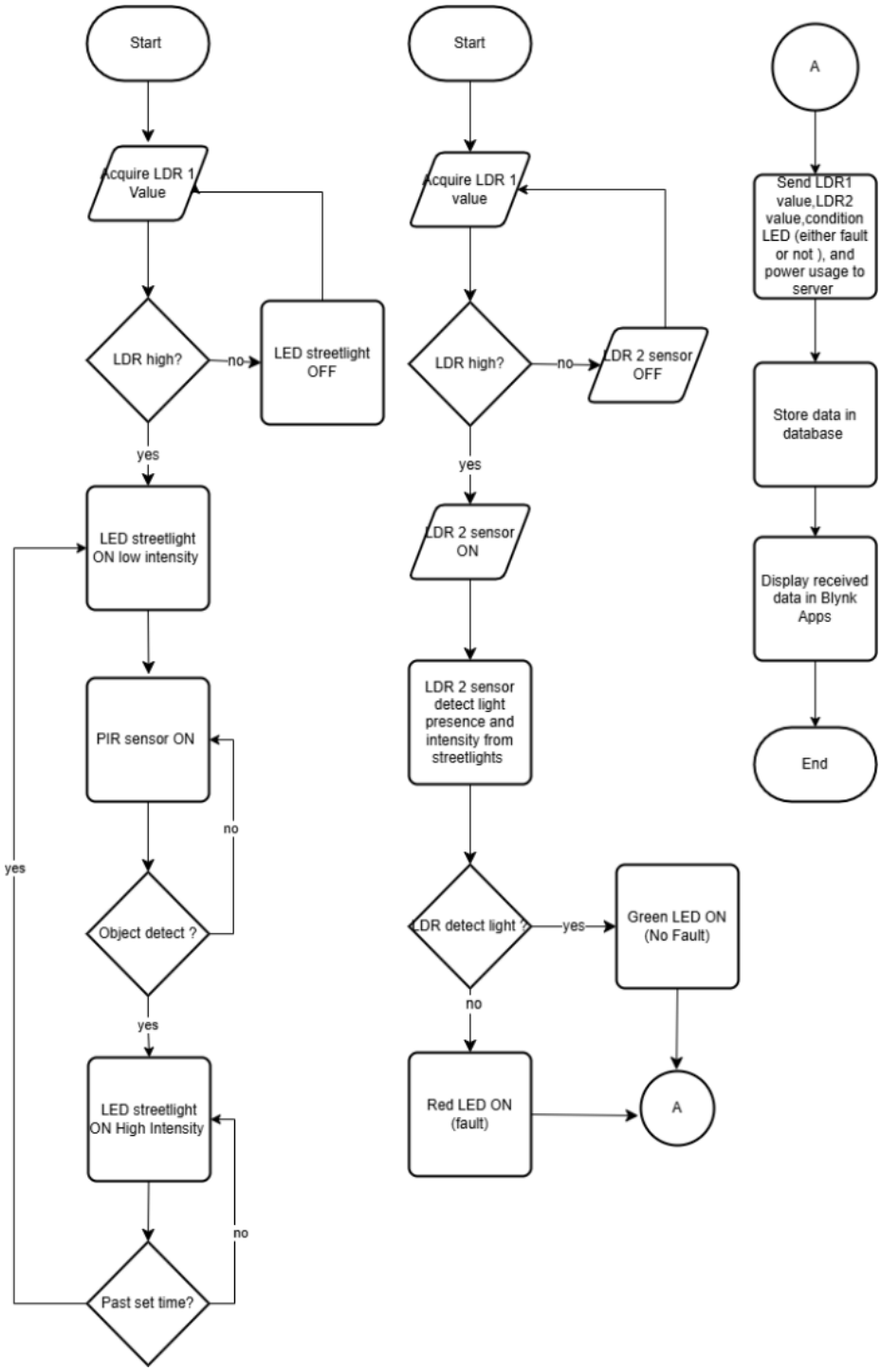

Figure 2. Model flow chart.

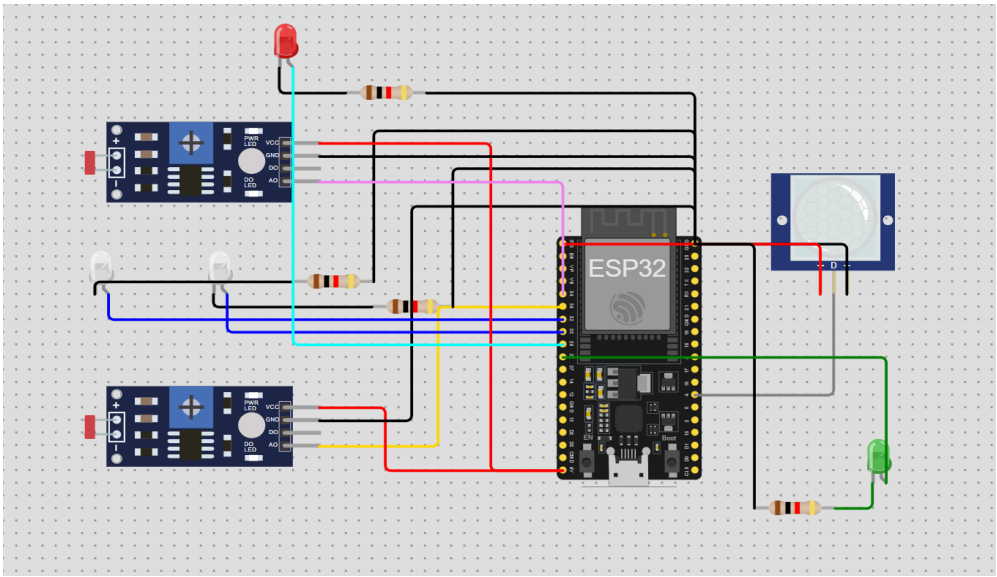

Figure 3. Schematic diagram.

3. Novelty and uniqueness

This innovative solution integrates renewable energy and IoT to create a sustainable lighting solution. It combines solar photovoltaic power with LDR sensors for precise light management and fault detection, and PIR sensors for dynamic brightness adjustment based on motion detection. Featuring Wi-Fi-enabled remote monitoring via an ESP32 microcontroller, the system provides real-time data and alerts through a mobile app, reducing manual inspections and enhancing maintenance. Its modular design ensures adaptability across various environments, promoting efficient, scalable, and sustainable infrastructure development.

4. Benefit to mankind

This system addresses critical needs by reducing dependency on grid power and minimizing greenhouse gas emissions, contributing to a healthier environment. It improves public safety through reliable lighting, reducing accidents and increasing visibility in poorly lit areas. The adoption of solar power lowers operational costs, making it accessible for rural and underserved regions with limited electrical infrastructure. With its fault detection and remote monitoring capabilities, the system ensures swift responses to issues, reducing downtime and improving overall reliability. This project offers an affordable, efficient lighting solution that positively impacts communities, economies, and the environment.

5. Innovation and Entrepreneurial Impact

By integrating IoT automation and renewable energy, innovation in lighting infrastructure is advanced through the Advanced Solar Street Lighting System with Fault Detection. Its modular, customizable design inspires creativity among engineers and entrepreneurs while creating opportunities in diverse markets, including municipalities, industrial zones, and rural communities. Supporting renewable energy and IoT services, the project promotes

economic growth and sustainability, fostering a culture of innovation and entrepreneurship in infrastructure development.

6. Potential commercialization

The system demonstrates strong commercialization potential with its modularity, cost-effectiveness, and adaptability. It can be marketed as a sustainable lighting solution for municipalities, industrial areas, residential zones, and rural communities. By integrating real-time monitoring and fault detection through a mobile app, it reduces maintenance costs while enhancing reliability. Its environmentally friendly design supports global sustainability efforts, making it an affordable, energy-efficient option with broad adoption potential.

7. Acknowledgments

Gratitude is extended to the faculty for the support and provision of resources and facilities necessary for the completion of this project. The assistance provided has been instrumental in ensuring the success of this work

8. Authors' Biography

Muhammad Danish Zakaria is currently pursuing a Diploma in Electrical Engineering (POWER) at the Electrical Engineering Studies, Universiti Teknologi MARA, Johor Branch, Pasir Gudang Campus. He has demonstrated outstanding performance in both academic and extracurricular activities, having earned a place on the Dean's List for whole consecutive semesters.

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